Bind this cover in front

# CHEMICAL EXAMINATION

OF THE

# URINARY CALCULI

IN THE

## MUSEUM OF THE MEDICAL DEPARTMENT

OF

## TRANSYLVANIA UNIVERSITY;

WITH

REMARKS ON THE RELATIVE FREQUENCY OF CALCULUS

IN

LEXINGTON, KY.,

AND THE

# PROBABLE CAUSES.

Presented by Robt Peter



BY ROBERT PETER, M. D.,
Professor of Chemistry and Pharmacy, in Transylvania University.

(Corrected by the author)

From the Western Lancet, Vol. V, No. 4.

LEXINGTON:
Scrugham & Dunlop, Printers.

1846

# CHEMICAL EXAMINATION

OF THE

# URINARY CALCULI,

IN THE

Museum of the Medical Department of Transylvania University.

The specimens submitted to the examination were 81 in number; of which 78 were from the human subject, having been, principally, removed by Dr. Dudley and Dr. J. M. Bush, in various operations of lithotomy and lithotrity; two are from the bladders of hogs, and one from that of a Jackass.

My principal object in the investigation, was to ascertain what relation, in composition, is borne, by the calculi of this region, to those of other parts of the world, as far as statistical information on the subject can be obtained, and to endeavor to learn, what influence is exerted, in the production or composition of these troublesome concretions, by the use of the *hard* or *limestone*, water and the rich "hog and homminy," or bacon and corn-bread, diet; so general among the mass of the inhabitants of the middle States, and especially in Kentucky.

It is much to be regretted, that the number of calculi submitted to examination is comparatively limited; representing but a very small proportion of the operations of Lithotomy, performed in this city by Dr. Dudley, during the last thirty years: he having attached little importance to the possession and preservation of the calculi, and having, generally, gratified the very natural wish of his patients, to carry off with them the cause of their sufferings.

*Mode of Examination.*—The detail of the processes, used in the chemical examination of any substance, should always accompany the results of the analysis; as it affords one indispensable means of judging of the *extent* and *accuracy* of the investigation. The history of the chemical analyses of urinary concretions will sufficiently illustrate this fact; particularly, in relation to the existence of the Urate of Ammonia as an ingredient of these bodies. The processes, used by some analysts, who have doubted its presence, having been insufficient for the accurate detection and estimation of the ammonia, and having, consequently, led them to consider the urate of ammonia, when present, as merely Uric acid.

It has long been known that the examination of the *external surface* of a calculus, even when a portion of it is removed, can give but a very imperfect knowledge of its nature and composition. It often happens that the interior is formed of a very different material from the *cortex;* the later being, in a great majority of cases, composed of earthy phosphates. In most of the specimens in the present collection, the exterior presented but little variety; while the exposure of the interior, by the operation of sawing, often disclosed the most interesting and varied alternations of deposits. Very frequently, the hard and dark colored mulberry calculus, with its rough and spinous surface, was found concealed under a white and comparatively soft deposite of mixed phosphates, which, filling up its deep entering angles, gave regularity to the exterior outline; and formed a general coating, a superficial fracture of which showed the dark points of the projecting processes of the interior body. Moreover, the most important portion of the calculus, in regard to its causes and production, is its *nucleus;* or the first formed solid concretion, produced most frequently in the kidnies, around which
rates, the Uric acid, or the earthy salts,—which are held in solution in the urine by a very weak affinity,—are easily, and often rapidly deposited, by cohesive attraction, or a rude species of crystallization. The fact that Dr. Marcet did not divide the calculi which

he examined in the Norwich Hospital collection, makes his results of little value compared with the subsequent ones of Dr. Yelloly.

The first process, therefore, was, by means of a sharp frame-saw, made of a piece of watch main-spring, to separate the calculus into two parts, as nearly as possible through the centre of the nucleus. The sawings and fragments were carefully preserved to be used occasionally in the chemical examination; and the cut surfaces of the stone well washed and carefully rubbed with an ordinary teeth-brush, in clean water, to remove the adhering powder and give a slight polish to the cut surface, which aids in the development of the characteristic appearances of the different deposits of which it is made up.

The color and general appearance of the exposed surface will usually give some idea of the chemical nature of the concretion; especially when some little experience has been acquired in this kind of examination.

The *Uric acid* concretion, is generally of a buff, tawny yellow, or reddish-brown color. It saws hard and the sawings are of the same color but of a lighter shade. *Urate of ammonia*, is usually of a grey or clay color, with a slight tinge of yellow, it is of a dull and earthy appearance, with no evidence of crystallization, and contrary to the statements of most writers, is sometimes aggregated into distinct and thin layers regularly superimposed.

*Cystine*, is of a light, waxy yellow color, on the recently exposed surface. It saws with great facility and the sawings are of a pure white. It acquires a deep, bluish, discoloration on exposure to light.

*Oxalate of lime*, or the mulberry calculus, is generally of a dark brown color, of various shades, often presenting the appearance of the American black walnut-wood; it is usually varied in color, in the cut surface, in irregular lines of lighter and darker, like the wavy lines of "fortification agate." It saws very hard, and the powder is of a lighter shade of the same color as the solid mass. The structure of this concretion as presented by a fracture, is often fibrous, like the mineral called satin-spar, the fibres being in the direction of the radius of the stone. Oxalate of lime is occasionally nearly white and crystalline. On several ~~one or two~~ specimens very beautiful transparent and colorless~~,~~ & minute octahedral crystals of this substance~~,~~ formed the exterior deposit. which were also observed on the interior layers of others.

The *earthy Phosphates*, are generally white, with a very slight tinge of dirty yellow. They generally yield to the saw with facility and the powder is white. The *triple phosphate*, (or ammoniaco-phosphate of magnesia,) is usually of a clearer white and more sparry appearance than the *mixed*, or *fusible phosphates;* which are generally porous and irregularly and imperfectly crystalline, and sometimes so soft on the exterior as to merit the denomination "chalky." The phosphate of lime I have observed, nearly pure, in but two specimens; in one of which it formed an interior compact deposit, of a light buff color; in the other it was of a white appearance and a fibrous structure, like satin-spar, forming the exterior layer on which were deposited the clear octahedral crystals of oxalate of lime already mentioned. In this layer, however, it was mixed with a small proportion of the triple phosphate.

If the calculus is homogeneous throughout, the sawings afford sufficient material for its *qualitative* analysis, as this, however, is not often the case, they can generally be employed only for certain specific processes, and portions of the nucleus and of the different layers must be separated for the purposes of analysis. For this use the least perfect half of the stone is taken, and by carefully breaking off small pieces of its different layers, or by scooping out some of the nucleus or of the thinner layers, as they are wanted, with a very small gouge, enough of the material can generally be obtained for the examination, without materially injuring the specimens for the museum: more particularly as the two halves should be mounted on paste-board, side by side, the one showing the cut surface and the other the exterior: for which latter purpose, the half which has furnished matter for the chemical examination may be appropriately employed.

If the object is to ascertain the exact relative proportions of all the different ingredients of the stone: in short, to perform a *quantitative* analysis of it; the sawings might be employed for the purpose. If, on the other hand, an accurate analysis of this kind is required of *each separate layer*, the one-half of the stone must be devoted to the examination; and the processes would be laborious and would require much time. But when the purpose is, as was ours, merely to learn the nature and composition of the different layers, and of the nucleus, without enquiring into the *exact relative proportions* of their ingredients, the examination is not so tedious, and the quantities required are much less.

In the chemical examination of these calculi, the first process was to expose a minute portion of the concretion or of its parts, severally, to the action of heat raised to incandescence, by placing it in a very small platinum spoon, or on a small piece of platinum foil, and holding it over the flame of a spirit lamp.

*If it burnt entirely away*, or left only a minute ash, it was known that it consisted of either, Uric acid, Urate of Ammonia, Cystine, Hypoxanthine or Xanthine. The characteristic color and appearance, of the deposit under examination, having usually given an index to its nature, the subsequent tests are accordingly applied to it to verify the supposition; as follows:

*Uric acid*, called also lithic acid, is known to be present, when, on adding a small portion to a little *diluted* pure nitric acid, in a very small procelain capsule, and heating it, it dissolves with effervesence and the evolution of fumes, and, on careful evaporation, without the application of too much heat, it leaves a beautiful pink colored coating on the capsule: which, when exposed to the gas emmitted from liquid ammonia, is changed to a handsome purple; and which dissolves in water without change of color.

If it is desired to test it further; its solubility in solution of caustic potash, and its insolubility in hydrochloric acid may be verified; but its combustibility, and peculiar reaction with nitric acid, are perfectly satisfactory.

By the application of the test of nitric acid, Uric acid will be found to exist, although often in minute quantities, in almost all the varieties of stone. Contrary to what is recorded of other collections, the proportion of *pure* Uric calculi in our collection is very small; as will be exhibited in the tables which will be given.

Treated in the same manner, with diluted nitric acid, *Cystine* leaves a colorless, or, if the acid is in excess, a light brown residuum. *Xanthine* dissolves without effervescence, and leaves a lemon-yellow substance, which is darkened by the addition of caustic potash solution. Hypoxanthine dissolves with the evolution of fumes, gives, on evaporation, a lemon-yellow residuum, like the preceding, which is reddened by the caustic potash.

In the Lexington collection, I was fortunate enough to meet with two specimens of that very rare substance *Cystine*, or *Cystic Oxide*; one of which weighed more than three-quarters of an ounce, and the other half an ounce; both had been fractured on one side, and, according to the best history which could be obtained of them, had been taken, at the same operation, from the bladder of patient from the mountainous portion of Virginia. x

They are both nearly spherical, externally slightly tuberculated and of a wax-yellow color, except on the part which had been most exposed to the light, which had acquired a bluish-grey tinge. This peculiar action of light on this variety of calculus, has been noticed by Dr. Bird, in some of the specimens in the Museum of Guy's Hospital, which have been exposed for a number of years, and which, although they were of a light-yellow color when they were deposited by Dr. Marcet, in 1817, have, for the last thirteen years, at least, been wholly of a bluish-grey appearance.

The interior structure of these calculi is irregularly crystalline, somewhat like that of the interior of a colored stalactite of carbonate of lime. The color is a light honey-yellow. The larger of the two has a nucleus about the size of a pea, which differs from the body, in being compact and close grained; presenting the appearance of old ivory, with many concentric lines of darker color. The other had no appearance of a nucleus. The powder was of a pure white, adhering to the pestle like magnesia.

On the application of heat to a fragment, it burnt with a bluish flame and a peculiar fœtid odor; leaving a bulky charcoal, which burnt with difficulty and left a small amount of ashes, which proved to be principally phosphates.

Heated in a glass tube, there rose and condensed in the cold portion of the tube, at first, a clear liquid depositing a white salt, and then, a thick empyreumatic oil, having a strong and *peculiar* fœtid odor. A bulky charcoal was left at the bottom of the tube.

It was found, on experiment, to be insoluble in water, alcohol, ether, oil of turpentine and acetic acid, and soluble in solution of caustic potash, liquid ammonia, sulphuric and nitric acids. Some of the characteristic chemical reactions of *Cystine*, as tested on the present specimens, are as follows; viz:

1. Its solubility in liquid ammonia into a colorless solution, from which it is precipitated by acetic acid.

2. The deposition, from its ammoniacal solution, on allowing a drop to evaporate spontaneously on a watch-glass, of minute transparent, colorless crystals, which, when examined with the

x I have since found another specimen (See my Laboratory Book) microscope, present the form of beautiful hexagonal plates, some aggregated together, and others having a central granular appearance. (See article Cystine, in Dr. Golding Bird's recent work on Urinary deposits, &c.)

This singular substance, which somewhat resembles a resinous or waxy body, or stearic acid, in its general appearance, but differs materially from each in almost all its properties, has been found to contain a large proportion of Sulphur;—more than 26 per cent.* This large amount of sulphur was overlooked in the first analysis made of it by Dr. Prout,—as was the case also in the analysis of one of the product ~~constituents~~ of bile,—the sulphur Taurine having been estimated as oxygen, because the combining proportion of the former, (16,) is a simple multiple of that of the latter, (8,) and the imperfect process employed was not adapted to the detection of the acids of sulphur. Liebig recommended to detect the sulphur of *Cystine*, by dissolving it in caustic potash solution and boiling it with a little acetate of lead; when the solution becomes of a dark color by the production in it of sulphuret of lead;—a reaction which he gives as characteristic of *Cystine*. The sulphur can, however, be as easily detected in the residuum left after the action of nitric acid on Cystine, by which action the sulphur is converted into sulphuric acid. If the evaporation is not carried wholly to dryness and the residuum is dissolved in water, the addition of Chloride of Barium causes a copius precipitate of Sulphate of Baryta.

That very rare substance, Xanthine, (called also Xanthic oxide and Uric oxide,) was not detected in any of the calculi from the human subject, but a very singular substance resembling it in some of its properties, was found to constitute a very large one, taken from the bladder of a hog, which will be described at the end of this paper. I found Hypoxanthine also in a Calculi from a Cow (see my Labr. B

*Urate of Ammonia*, (called also Lithate of Ammonia,) when examined only by heat and by the action of nitric acid, gives indications which do not materially differ from those of pure Uric acid. In other words, it wholly consumes when heated in the open air, or leaves but a minute ash, and forms the pink residuum when treated with diluted nitric acid. It also dissolves wholly in solu-

* Its composition is (C 6, N. H 6, O 4, S 2.

tion of potash; but evolv~~ing~~es ammonia, ~~it is true,~~ upon being heated; and is partly soluble in hydrochloric acid,—which takes up the ammonia and leaves the Uric acid. It has, therefore, been often confounded with pure Uric acid; and some of the chemists, who first turned their attention to the examination of Urinary culculi, as Scheele, Wollaston, Brande, Marcet and Henry, ~~were unable~~ failed to detect it. Some of them were hence disposed to doubt the statement of MM. Fourcroy and Vauquelin,—who first discovered it,—that it is a constituent of those concretions. Its presence has, however, been subsequently ascertained in some of the same specimens which had been submitted to their experiments.

No case of this kind is more remarkable than that of the 142 calculi which were removed by Sir A. Cooper, from one patient. Of these Dr. Marcet records, (see his work on Calculous Diseases, p. 54,) "They consist of Lithic acid in a state of tolerable purity." But Dr. Bird has ascertained * that these singular concretions, which have the color of pipe-clay, "have their bodies chiefly composed of Urate of Ammonia." Dr. Henry, of Manchester, although he believed, with Mr. Brande, that MM. Fourcroy and Vauquelin were in error, when they classed the Urate of Ammonia among the ingredients of Urinary Calculi, yet admits that he was never able, in his analyses, "to recover a quantity of Uric acid equivalent to the weight of the calculus dissolved,—the utmost ever obtained was 92 per cent." It is, therefore, more than probable that this ingredient has been overlooked, even in comparatively recent analyses, and that a great number of those calculi, or nuclei, which have been set down as Uric acid, contain more or less of Urate of ammonia, and that, therefore, the the statistical results in relation to these two substances, severally, are not to be wholly relied on.

The researches of Dr. Bird and others, have shown that the Urate of Ammonia is one of the most frequent of urinary deposits; and according to my experience, with the calculi submitted to my examination, this substance is very often present in these concretions; forming the nucleus more frequently than any other compound. The mode by which it was separated and detected, in the present examinations, is as follows; viz: a small portion

* Guy's Hospital Reports, No. XIV, p. 196.

was rubbed to fine powder, in a little agate mortar, and then boiled in distilled water in a small porcelain capsule. Urate of Ammonia, which is soluble in about 480 parts of boiling water, is thus readily separated from the pure uric acid and the earthy salts. The urates of lime and soda are also taken up by the boiling water at the same time.

The clear solution, decanted off from the sediment, is then carefully evaporated to dryness, and a new solution of it made with diluted hydrochloric acid which decomposes it, separating the Uric acid and forming hydrochlorates with the ammonia and other bases present. The uric acid is allowed to subside, the clear solution is carefully evaporated and the dry residuum is introduced into a very small ~~glass~~ test tube, ~~closed at one end~~, and heated. The hydrochlorate of ammonia sublimes and is easily separated from the *fixed* chlorides by cutting off the end of the tube with a file. By dissolving the fixed residuum in a little water the chlorides of ~~lime~~ calcium and of sodium, derived from the decomposition of the Urates of lime and soda are easily detected and estimated in the usual way.

By this process all sources of fallacy are avoided, ~~except that~~ unless ~~of the original presence of~~ hydrochlorate of ammonia is present in the calculi; which Mr. Brande supposed to be sometimes the case. This, in view of the great solubility of that salt in the urine, is very improbable, and ~~the presence of~~ this salt can always be ~~avoided~~ removed by washing the powder in cold water before submitting it to the action of boiling water. But on performing this experiment on some urate of ammonia, contents I found that a very small quantity was dissolved, which was principally animal matter.

Urate of Ammonia, when exposed to the action of heat, *decrepitates* strongly, unless it be very slowly heated; a character which was supposed to belong occasionally to Uric acid. A very large proportion of the present collection contained Urate of Ammonia, of which it formed the *nucleus* of ~~more than~~ nearly 54 per cent.; the duplicate calculi being excluded.

If on exposure of the fragment to heat in the open spoon, it is consumed only in part and left a large proportion of ashes, these were examined for carbonate of lime and the earthy phosphates.

If the fragment merely blackened and exfoliated, or swelled up into a mass of grey powder, which, when placed in hydrochloric

+ of a calculus

acid, rapidly dissolved with a lively effervescence; the substance was known to be *Oxalate of lime*. If this be intensely heated, before the blow-pipe, for a sufficient length of time, nothing but caustic lime is left; which is known by its slacking with water, and reddening turmeric paper. But the easier and equally characteristic process is, to heat it in the platinum spoon over the spirit lamp, when, by the decomposition of the oxalate, carbonate of lime is the product. This, dissolved in diluted hydrochloric acid, and agitated or heated, to drive off the free Carbonic acid is super-saturated with pure ammonia; which will precipitate any phosphates that may be present. Oxalate of ammonia, subsequently added, will precipitate the lime as an oxalate. The presence of carbonate of lime in the original concretion is easily ascertained by its effervescence with hydrochloric acid, before heating it.

If it be desired to separate the Oxalic acid, all that is necessary is to boil the powdered specimen with solution of carbonate of potash or soda; which, by double decomposition, will from carbonate of lime and a solution of oxalate potash or soda, from which the oxalic acid can be precipitated by the appropriate reagents.

If on exposure of the fragment to heat it merely blackened, gave off the odor of burnt animal matter, but neither consumed or exfoliated and fell to powder, and if, after heating it, dissolved in nitric or hydrochloric acids, without effervesence, the substance was supposed to be *earthy phosphates*.

A fragment was exposed to the ordinary blow-pipe; if it did not readily fuse it was considered either phosphate of lime or the ammoniaco-phosphate of magnesia, (called the triple phosphate,) or a mixture of a large proportion of the one with a *small* quantity of the other. If, on the contrary, it *readily fused* into a bead, which became white and opake on cooling, it was supposed to be the mixture of the two phosphates, called by Dr. Wollaston, *fusible* calculus. Those familiar with the use of the mouth blow-pipe, may apply the the nitrate of cobalt to the assay; which, by the production of a rose color, in the subsequently melted mass, will indicate the presence of magnesia. But the most ready and certain mode of determining the variety of phosphate which is present, is to apply liquid reagents, as follows:

1. A small quantity of the calcined mass is pulverized and dissolved in nitric acid; a little solution of nitrate of silver is then added, and liquid ammonia applied, *guttatim*, until the point weak of saturation is accurately attained; at which point, if the assay is a *phosphate*, a precipitate will appear of tri-basic phosphate of silver, presenting a light yellow color.

2. To determine the character of the phosphate, a little of the pulverized assay is placed in a small quantity of diluted sulphuric acid; which will wholly dissolve the triple phosphate of magnesia; but will form a difficultly soluble sulphate of lime, if any phosphate of lime is present. dilute

The triple phosphate is also soluble in acetic acid in which the phosphate of lime is nearly insoluble.

3. To determine the relative proportions of the phosphates of lime and magnesia, a particle of the calcined assay was dissolved in hydrochloric acid; ammonia was then added *almost* to saturation. Oxalate of Ammonia then added, precipitated the lime. After filtering the liquid the addition of ammonia caused the precipitation of any magnesian ~~salt~~ which might be present. phosphate

The *fusible variety* or mixture of the phosphate of lime and the triple phosphate of magnesia, is more frequent than either of its constituents. It will be seen that in our collection the earthy phosphates exist in much more than the average proportion. As already mentioned, the phosphate of lime, nearly pure, was found but in two specimens. The triple phosphate was found to compose the principal mass of four; of which three had *foreign substances* for their nuclei; and in a remarkable calculus, of large size, and nearly perfectly ~~u~~niform, taken from a patient from one re of the upper counties of Missouri, which the section showed to be made up, in the interior, of three several bodies, like three distinct calculi, joined together by and imbedded in a common coating of fusible phosphates,—two of these bodies were mainly composed of the triple phosphate, while the largest one, containing a distinct nucleus, was formed of oxalate of lime.

In accordance with the general experience, the earthy phosphates, (generally mixed,) formed the outer coating of most of our specimens; and, as was remarked by Dr. Prout, it rarely happened that any other deposition was observed after a decided formation of the mixed phosphates. ~~Two~~ cases were presented,

Several

Sometimes in clear crystals



however, in the present collection, in which oxalate of lime, in small amount, was exterior to a decided layer of phosphates.

Carbonate of lime was frequently found in company with the phosphates, but not in large proportion.

The processes above detailed, were all carefully employed in the present examination, with pure reagents; and the reader will thus be able to judge of the relative accuracy of the results; which will be presented in a tabulated form.

The calculi of our collection, classified according to the arrangement of Dr. Bird, as follows, viz:

GENUS I.—NUCLEUS URIC ACID. - - - - **32**

SPECIES 1.—*Calculi almost entirely composed of Uric Acid.*

A. Containing a little Urate of Ammonia, - - 1

B. Containing Urates of Ammonia, Lime and Soda, 31*

GENUS II.—NUCLEUS URATE OF AMMONIA, - - - **36**

SPECIES 1.—*Calculus nearly all Urate of Ammonia.*

Containing some phosphates, - - - - 2

SPECIES 2.—*Bodies differing from the nuclei,* - 24

| *Body*: | *Cortex:* | |
|---|---|---|
| Fusible. | Ditto. - | 6 |
| Oxalate of lime. | Ditto. - | 3 |
| " " | Phosphates. | 11 |
| Uric acid, urate of ammonia and phosphates. | Oxalate of lime. | 1 |
| Do., oxalate of lime and urate of ammonia. | Phosphates. | 1 |
| Do., phosphates and oxalate of lime. | Phosphates. | 1 |
| Do., oxalate of lime. | Phosphates. | 1 |

GENUS III.—NUCLEUS, OXALATE OF LIME, - - - **7**

SPECIES 1.—*Calculi nearly all oxalate of lime,* - 2

SPECIES 2.—*Bodies differing from the nuclei,* - 5

| *Body*: | *Cortex:* | |
|---|---|---|
| Fusible phosphates. | Same. - | 1 |
| Urate ammonia and phosphate of lime. | Fusible. - | 1 |
| Oxalate of lime and triple phosphate. | Fusible. - | 1 |
| Phosphate of lime & triple phosphate. | Oxalate of lime. | 1 |
| Oxalate of lime and uric acid, with phosphates. | Crystals of oxalate of lime. | 1 |

* From the same patient.

GENUS IV.—NUCLEUS, EARTHY PHOSPHATES. - - - 7

| *Body:* | *Cortex:* | |
|---|---|---|
| Fusible. | Same. - | 1 |
| Triple phosph., with traces of carb. and oxalate of lime. | Same. - | 1 |
| Fusible. | Oxalate of lime. | 1 |
| Fusible, with a layer of oxalate. | Fusible. - | 1 |
| Fusible, with a layer of urate of ammonia. | Fusible. - | 1 |
| Fusible, with a layer of phosphate of lime. | Fusible. - | 1 |
| Fusible, with traces of oxalate. | Same. - | 1 |

GENUS V.—NUCLEUS, A FOREIGN SUBSTANCE. - - - 4

A. *Nucleus a small bean.* - - - - - - 2

Bodies principally triple phosphate, with a little phosphate of lime and Urate of ammonia.*

B. *Nucleus a piece of decayed bone.* - - - - 1

Body principally fusible phosphates, with a trace of Uric acid and Urates. Cortex the same.†

C. *Nucleus a small film of animal matter,* probably the remains of a clot of blood. - - - - - 1

Body principally fusible phospates. Cortex the same.‡

GENUS VI.—NUCLEUS, CYSTINE. - - - - - - 2

*All Cystine.* - - - - - - - - 2

ABSTRACT VIEW.

Of the 78 calculi the composition of the *Nuclei* is as follows:

| | | | |
|---|---|---|---|
| Uric acid | mainly, in | - - | 32 |
| Urate of ammonia | " " | - - - | 26 |
| Oxalate of lime | " " | - - | 7 |

* These two remarkable calculi, which originally weighed nine ounces, and at present weigh seven, were taken from the bladder of Steele, whose case is mentioned by Dr. Dudley in his paper on Calculous Diseases in the Transylvania Medical Journal. They were originally involved, and cemented into one mass, by a friable coat of fusible phosphates; which was broken off by repeated falls,—old Mr. Beatty having carried them for a length of time in his pocket as a curiosity.

† From the bladder of a boy.

‡ Taken from the bladder of negro Mat, from the neighborhood of Louisville, by Professor Bush, about six months after a previous operation, by which two calculi, of the fusible variety, were removed.

| | | |
|---|---|---|
| Phosphates | " " | 7 |
| Foreign substances | " " | 4 |
| Cystine | " " | 2 |
| The *Bodies* are composed as follows: | | |
| Of Uric acid | mainly, in | 34 |
| " Urate of ammonia, etc. | " " | 2 |
| " Oxalate of lime | " " | 16 |
| " Mixed phosphates | " " | 16 |
| " Triple phosphates | " " | 4 |
| " Cystine | " " | 2 |
| In addition: | | |
| Uric acid exists in *notable proportion* in | | 4 |
| Urate of ammonia | " " " | 24 |
| Oxalate of lime | " " " | 9 |
| Mixed phosphates | " " " | 15 |
| Phosphate of lime | " " " | 2 |
| The *Cortex* or outer layer was of Uric acid in | | 34 |
| Of Urate of ammonia, with phosphates, & oxalate | | 2 |
| " Oxalate of lime | " " | 9 |
| " Mixed phosphates | | 37 |
| " Triple phosphate | | 2 |
| " Cystine, | | 2 |

Comparative views of the statistics of calculi; their relative frequency; the nature of their nuclei; and the proportions of the principal ingredients of their bodies; cannot fail to be interesting, as well as useful in the study of the several causes of these troublesome concretions. Accounts have been published of the composition of a large number of calculi, in various parts of the world; but from the imperfections of the mode of examination adopted by some, and the different manner of stating the results, it is more difficult to make a statistical comparison than at first sight might appear.

Another cause of inaccuracy, which has apparently been overlooked, is, that the tables published are generally of the *number of the calculi* of various kinds, and not of the *number of patients* from whom they were extracted. This makes an important difference in the value of the statistics in relation to the frequency of the various forms of urinary deposits, as may be seen from a single example.

Dr. Bird, in his paper on the calculi in Guy's Hospital Museum, gives a very satisfactory account of the composition of 353 of these concretions, of which 269 are mainly composed of Uric acid and Urates. But he merely incidentally mentions the fact that 142 of these were taken from one patient, and is altogether silent as to any other duplicate calculi, which no doubt exist in the collection. His numbers, as probably those of most other writers on the subject are, therefore, likely to lead to erroneous conclusions; more particularly in relation to the relative frequency of concretions of Uric acid and Urate of ammonia: these being the varieties which are most often found in the bladder in the form of a considerable number of small stones.

Mr. Smith* remarks, in relation to the 74 calculi of Uric acid in the Bristol collection, that "in several instances 3, 4, 5 and 6 were removed by one operation."

A case has been mentioned in this country, that of the late Chief Justice Marshall, in which the number of calculi was said to amount to a thousand.

In the Lexington collection, thirty-one, principally composed of Uric acid, were taken from one patient;† two, principally of and
Urate ammonia; two, of fusible phosphates; two, of the triple phosphate, with beans for nuclei; two, of Cystine: ~~which~~ were &
each, severally, taken from one patient. The comparison made, therefore, of the number of *cases*, would be materially different from that made with the number of *calculi*, as it is usually drawn; and would, moreover, be of much more value in an ætiological sense.

I have been at the trouble to collate, from all the sources within my reach, the statistics relative to the composition of urinary calculi, and as far as possible have excluded the duplicates, as well as those which were imperfectly examined,—an exclusion which could only be made in a few instances. Between these and our collection, I have endeavored to draw a comparison. Having also excluded our duplicates, and reduced the numbers to those of the patients.

The results to which I have had access, are in the papers of the following gentlemen, to whose names I have appended the number of calculi they examined, to-wit:

---

* Med. Chir. Trans., vol. xi, p. 10.

† Dr. Barnett, of Bourbon county, Ky. Dr. Dudley informs me that he removed 13 from another patient, Parson King, from the banks of the Cumberland; and that in a dozen other cases he has taken from 2 to 6 from the same patient: most of these were not preserved for the Museum.

| | | |
|---|---|---|
| *1. | Mr. Brande, | 150 |
| 2. | Dr. Henry, of Manchester, | 187—8=179 |
| 3. | Dr. Yelloly, of Norwich, | 663 |
| 4. | Mr. Smith, of Bristol, | 218—18=200 |
| 5. | Mr. Taylor, Bartholomew's Hospital, | 129—8=121 |
| 6. | Rapp, of Wurtemberg, | 81 |
| 7. | Dr. Wood, collection of Canterbury Hospital, | 167—2=165 |
| 8. | Scharling, Copenhagen, | 155 |
| 9. | Dr. Bird, Guy's Hospital collection, | 343—141=212 |
| | Total number | 1926 |

From these publications the following statistics were obtained,—the small fractions having been excluded,—viz:

A. *In relation to nuclei*, as far as could be ascertained,—their nature not having been stated in some of the papers referred to,—the proportions are as follows:

I. NUCLEUS, URIC ACID OR URATES.

| Collection. | | | Per cent. |
|---|---|---|---|
| *Henry.* | Uric acid, | | 84½ |
| *Yelloly.* | Uric acid, | about 41 per cent. | 79½ |
| | Ur. ammonia, | " 38½ " | |
| *Smith.* | Uric acid, | " 39½ " | 40 |
| | Ur. ammonia, | " ½ " | |
| *Taylor.* | Uric acid, | " 22¼ " | 52½ |
| | Ur. ammonia, | " 30¼ " | |
| *Wood.* | Uric acid, | | 57½ |
| *Scharling.* | Uric acid, | " 61 " | 65½ |
| | Ur. ammonia, | " 4½ " | |
| *Bird.* | Uric acid, | " 51½ " | 60½ |
| | Ur. ammonia, | " 9 " | |
| | General average, per cent. | | 6~~2½~~ 3, (nearly) |
| *The Lexington collection.* | Uric acid, | about 4½ per cent. | 59 |
| | Ur. ammonia, | " 54½ " | |

It will be seen, by the above table of the composition of the nuclei, that the *combined* per centage of Uric acid and Urates, in Lexington collection, does not differ very materially from the

*1. Philosophical Trans. Roy. Soc., 1808.
2 Med. Chir. Trans., vol. 10.
3. Phil. Trans. Roy. Soc., 1829 and 1830.
4. Med. Chir. Trans., vol. ii.
5. Lond. Med. Gaz., N. S., vol. ii, 189.
6. 7. From Prout on Stomach and Renal Diseases, Simon's Chemistry of Man, and Berzelius.
8. Scharling on Vesical Calculi.
9. Guy's Hosp. Rep's, vol. vii, & Bird on Urinary Deposits, appendix.

general average. But it will be noted, that the proportion of the Urate of ammonia nucleus is immensely greater than in any other collection.

II. NUCLEUS OF OXALATE OF LIME.

| Collection. | Per cent. |
|---|---|
| Henry, | 9 |
| Yelloly, | 13¼ |
| Smith, | 43 |
| Taylor, | 24 |
| Wood, | 14½ |
| Scharling, | 18 |
| Bird, | 22¼ |
| General average, | ~~19~~ 20½ |
| Lexington collection, about | 16 |

III. NUCLEUS, EARTHY PHOSPHATES.

| Collection. | Per cent. |
|---|---|
| Henry, | about 2 |
| Yelloly, | 7¼ |
| Smith, | 9 |
| Taylor, | 9 |
| Wood, | 16 |
| Scharling, | 9 |
| Bird, | 10¼ |
| General average about | ~~8½~~ 7 |
| Lexington collection. | 16 |

IV. NUCLEUS, A FOREIGN SUBSTANCE.

| Collection. | Per cent. |
|---|---|
| Scharling, | 1 3-10 |
| Taylor, | 2 3-10 |
| Henry, | 1 |
| Our collection, | 4½ |

V. NUCLEUS, CYSTINE.

| Collection. | Per cent. |
|---|---|
| Henry, | 1 6-10 |
| Taylor, | 1½ |
| Smith, | 9-10 |
| Wood, | 1 2-10 |
| Bird, | 5 2-10 |
| General average, | 1 1-10 |
| Lexington collection, | 2 2-10 |

The large proportion of the nuclei of earthy phosphates in the Lexington collection, 16 per cent., compared with the average per centage, ~~$8\frac{1}{2}$~~ nearly 9, cannot fail to strike the reader. The only other collection which resembles it in this relation, is that of Canterbury Hospital, as represented by Dr. Wood,—they also have this other point of similarity, that they are both principally from a *limestone* region: the county of Kent being in the chalk formation, and our prevailing rocks being limestones of a more ancient origin. The natural waters of that region, like those of this, are doubtless strongly impregnated with carbonate of lime.

The comparison made between these different collections and our own, in relation to the composition of the *bodies* of the calculi, is also interesting, and may be stated as follows, viz:

I. CALCULI CONTAINING URIC ACID OR URATES.

| Collections. | A. Mainly composed of Uric acid or Urate ammonia. | Per cent. | B. Containing Ur. ac. or Ur. am. in notable proportion. | Per cent. | Totals. |
| --- | --- | --- | --- | --- | --- |
| Brande. | - - | $40\frac{2}{3}$ | - - | $53\frac{1}{3}$ | $=94$ |
| Henry. | - - | $39\frac{2}{3}$ | - - | $34\frac{2}{3}$ | $=74\frac{1}{3}$ |
| Yelloly. | Uric acid, $24\frac{3}{4}$<br>Ur. ammonia, $8\frac{1}{3}$ | 33 | $27\frac{3}{4}$ -<br>$33\frac{1}{4}$ - | 61 | $=94$ |
| Smith. | - - | 37 | - - | $45\frac{1}{2}$ | $=82\frac{1}{2}$ |
| Taylor. | Uric acid, 9<br>Ur. ammonia, $6\frac{2}{3}$ | $15\frac{2}{3}$ | 20 -<br>27 - | 47 | $=62\frac{2}{3}$ |
| Rapp. | Uric acid, $8\frac{1}{2}$<br>Ur. ammonia, $1\frac{1}{4}$ | $9\frac{3}{4}$ | - - | 11 | $=20\frac{3}{4}$ |
| Wood. | - - | 28 | Uric acid, $39\frac{1}{3}$<br>Ur. am'a. $3\frac{2}{3}$ | 43 | $=71$ |
| Scharling. | Uric acid, 60<br>Ur. ammonia, 2 | 62 | 5<br>5 - | 10 | $=72$ |
| Bird. | Uric acid, 33<br>Ur. ammonia, 4 | 37 | $28\frac{1}{3}$<br>$8\frac{2}{3}$ - | 37 | $=74$ |
| General | averages, nearly | ~~35~~ 33.64 | - | ~~45~~ 38.05 | ~~=80~~ 71.69 |
| Lexington collection. | Uric acid, $4\frac{1}{2}$<br>Uric ammonia, $2\frac{1}{4}$ ate | $6\frac{3}{4}$ | $9\frac{1}{4}$<br>$54\frac{1}{2}$ | $63\frac{3}{4}$ | $=70\frac{1}{2}$ |

The proportion of pure Uric acid and Urate of ammonia calculus, in our collection, it will be seen, is very much below the general average; in the proportion of $6\frac{3}{4}$ to nearly 35; while Urate of ammonia exists in *notable proportion*, in a number of calculi greatly above the general average.

(The above fractions should all be reduced to decimals)

## II. CALCULI CONTAINING OXALATE OF LIME.

| Collection. | A. Mainly composed of it. Per cent. | B. Containing it in notable proportion. Per cent. | Totals. |
|---|---|---|---|
| Brande, : : | 4 | | =4 |
| Henry, : : | 6 | 19 | =25 |
| Yelloly, : : | 3 | $33\frac{1}{3}$ | $=36\frac{1}{3}$ |
| Smith, : : | $16\frac{1}{2}$ | 57 | $=73\frac{1}{2}$ |
| Taylor, : : | $6\frac{2}{3}$ | 42 | $=48\frac{2}{3}$ |
| Rapp, : : | 27 | 42 | =69 |
| Wood, : : | 3 | 19 | =22 |
| Scharling, : : | 15 | $35\frac{1}{2}$ | $=50\frac{1}{2}$ |
| Bird, : : | 14 | 21 | =35 |
| General average ~~more than~~ about | 10.57 ~~8~~ | 29.87 ~~32~~ | ~~=38~~ 40.45 |
| Lexington collection, | $36\frac{1}{2}$ | $20\frac{1}{2}$ | =57 |

The proportion of the calculi composed mainly of oxalate of lime, or the *Mulberry calculi*, in our collection, is larger than the average; and is only excelled by that of Rapp of Wurtemberg, and Smith of Bristol.

It may be remarked in this connection, that the nucleus of a great majority of our Mulberry calculi is Urate of ammonia.

## III. CALCULI CONTAINING EARTHY PHOSPHATES.

| Collections. | A. Mainly composed of them. Per cent. | B. Containing them in notable proportion. Per cent. | Totals. |
|---|---|---|---|
| Brande, : : | 52 | $33\frac{1}{3}$ | $=85\frac{1}{3}$ |
| Henry, : : | 6 | $34\frac{2}{3}$ | $=40\frac{2}{3}$ |
| Yelloly, : : | $5\frac{1}{4}$ | 26 | $=31\frac{1}{4}$ |
| Smith, : : | 10 | $20\frac{1}{2}$ | $=30\frac{1}{2}$ |
| Taylor, : : | 16 | 48 | =64 |
| Rapp, : : | $8\frac{1}{2}$ | 16 | $=24\frac{1}{2}$ |
| Wood, : . | 24 | $31\frac{1}{2}$ | $=55\frac{1}{2}$ |
| Scharling, : : | $14\frac{1}{4}$ | $22\frac{1}{2}$ | $=36\frac{3}{4}$ |
| Bird, : : | 29 | $9\frac{1}{2}$ | $=38\frac{1}{2}$ |
| General average ~~above~~ about | ~~16~~ 18.33 | ~~36~~ 26.89 | ~~=41~~ 45.22 |
| Lexington collection | nearly 41 | $36\frac{1}{2}$ | $=77\frac{1}{2}$ |

It will be seen that the *earthy phosphates* exist, in the calculi of our collection, in much larger proportion than the general average; being exceeded in this respect only by those of the collection examined by Mr. Brande. His account is, however, very imperfect in many particulars. It was written in 1808, when it was not customary to divide the calculi in order critically to examine the interior, and he consequently gives no regular account of the nuclei. It is well known the earthy phosphates form the exterior of a great majority of these concretions.

The peculiarities presented by the Lexington collection, as composed with the others whose history we have been able to a learn, are as follows:

A. *As it regards the nuclei.*

1. A great deficiency in the proportion of pure Uric acid.
2. A great excess in the proportion of nuclei of Urate of ammonia and of the earthy phosphates.

B. *In relation to their general composition.*

The same peculiarities pointed out above in regard to nuclei, with the additional one:

3. An excess in the proportion of the mulberry, or oxalate of lime, calculus.

In the whole collection, two cases only × are represented of which the concretions were mainly composed of pure Uric acid, viz: the 31 small calculi from the patient from Bourbon county, Ky., and a single oval calculus, weighing seven drachms; taken by Dr. J. M. Bush from the bladder of Mr. Williamson of Lincoln county.

Bourbon county is principally in the "Blue Limestone" region; but the portion of Lincoln county in which Mr. Williamson resides, is in either the dark colored slate, or the sandstone, which bound the limestone; and the water used there is probably not greatly contaminated with the carbonates of lime and magnesia. So that we really have, represented in our collection, but one case of pure Uric acid calculus from the limestone region.

The case of Parson King, who had thirteen calculi,—which were probably of Uric acid,—was from the banks of the Cumberland river; also in the sandstone region.

*The relative frequency of calculous disease in Lexington.* As I have no means of ascertaining the exact number of cases in any other portion of *our limestone region*, my statistics, as to the frequency of calculus, are confined to the city of Lexington; which

× I have since found more. P.

is located within the geological *formation*, called by our Western geologists the great *blue limestone.*

On reference to the Assessor's books,—through the kindness of our city clerk,—I find the population of Lexington, at present, (1846) to be 8,400. In the year 1816, it was 5,448; and in 1820, it was 4,267. During the last thirty years, the average population was 5,885; and in that space of time, Dr. Dudley informs me, he recollects the occurrence of eleven calculous cases within the city. Three men and eight boys,—of whom one was a negro. ✗

This gives the annual proportion of calculous disease in the city of Lexington of 1 in 16,050.

A very remarkable fact is, that Dr. Dudley recollects but two cases in the city within the last fourteen years.

On examining the statistics of the relative frequency of calculus,—furnished by Yelloly, Smith, Civiale, and others,—I find the following proportions:

| Countries. | No. of cases per annum. | Authority. |
|---|---|---|
| Ireland, the pauper population, | 1 in 875,000 | Dr. Yelloly. |
| " City of Cork, | 1 " 800,000 | Dr. Civiale. |
| Bohemia, - - - | 1 " 347,000 | " |
| Islands of Malta, Goze and Cumino, | 1 " 300,000 | " |
| Cornwall and Devonshire, (England,) | 1 " 293,000 | Dr. Smith. |
| Glasgow, - - - | 1 " 77,000 | Dr. Yelloly. |
| Ionian Islands, - - | 1 " 60,000 | Dr. Civiale. |
| Bristol, (England,) - - | 1 " 41,000 | Dr. Yelloly. |
| Lombardy, - - - | 1 " 38,500 | Dr. Civiale. |
| London, - - - | 1 " 38,000 | Dr. Yelloly. |
| County of Norfolk, - - | 1 " 34,000 | " |
| Copenhagen, - - . | 1 " 22,000 | Dr. Civiale. |
| City of Norwich, - - | 1 " 21,000 | Dr. Yelloly. |
| City of Lexington, . - | 1 " 16,050 | |

The predisposition to this disease appears, therefore, to be much greater in Lexington than in any of the places mentioned above. But there is this fact to be taken into the account; which will somewhat diminish this apparent excess, viz: that while the *whole number of cases*, which have occurred in Lexington, during the last 30 years, is probably given, those of the other accounts are generally *Hospital cases* only, and the numbers do not, therefore, represent the *full proportion* of the several localities named. It is still evident that a greater than the average predisposition, to this painful disease, exists in this region of

✗ I believe no other surgeon but Dr Dudley operated for stone in Lex. during this period.

country; and it is a question of some importance;—to what causes it is to be attributed?

*Limestone water.*—One of the most prominent peculiarities of limestone regions, is the contamination of the water, of springs and wells particularly, with the carbonates of lime and magnesia. Water which has percolated the soil always contains Carbonic acid in solution, and is thus capable of dissolving these carbonates in considerable proportion. Exposure of this water to the air, or to the boiling temperature, causes the escape of the carbonic acid and the consequent deposition of the earthy salts in the solid form. In this manner are produced many of the stalacties and incrustations of caverns, and the hard calcareous coating on the inside of the tea-kettle or the boiler, so common in limestone regions.

as well as phosphates lime and magnesia

In order to ascertain the amount of this contamination in the water used in our city, I took two specimens, from two different deep wells, and evaporated of each a fluid ounce in a weighed porcelain capsule. The one left three-tenths of a grain of solid matter and the other 27 hundredths of a grain. The average of the two being 0.285 grain. On examination, with the appropriate reagents, this residuum was found to consist, principally, of the carbonates of lime and magnesia, with a small proportion of the chlorides of calcium and magnesium, &c.

If we suppose only two-tenths of a grain of this residuum to be earthy carbonates, we have 3.2 grains to the pint of water; and if a person drinks half a gallon of it in the day, he takes into his system, at the same time, 12.8 grains of carbonates of lime and magnesia, which will unite with any of the acids of the animal economy, and thus tend to neutralize those fluids, secretions or excretions, which are naturally in an acid condition.

In this manner, limestone water may, for a time, interfere with the digestive process, in persons unaccustomed to its use, by neutralizing more or less of the hydrochloric acid which is naturally secreted in the gastric juice; or it may reduce the natural acidity of the cutaneous secretion, or of the urine. In either case it may derange the general system and thus increase the predisposition to urinary deposits.

But this water introduces directly, into the mass of fluids, a *considerable amount of earthy salts which must be discharged by the* *kidnies;* increasing the proportion of solid matters to be excreted by those organs, and loading the urine with substances of difficult solubility. No one can believe that when this water is absorbed into the mass of fluids, it parts with its earthy salts. They, therefore, go to increase the amount in the system, derived from the food, (which ~~always~~ generally contains a sufficiency for the wants of the economy,) and, combining with the hydrochloric, sulphuric, phosphoric ~~and~~ oxalic acids, which they may meet with in the fluids, and other they pass out in the urine, as chlorides of calcium and magnesium, sulphates of lime and magnesia, mixed phosphates of lime, ammonia and magnesia, and oxalate ef lime, &c, &c.

The use of this water, therefore, not only increases the amount of those ingredients in the urine which most frequently form the bodies of calculi in this region, viz: the earthy salts; but they, by diminishing the natural acidity of this excretion, bring it to the condition most favorable to a deposition of those substances, and the urin whenever the cohesive attraction of a nucleus, or a foreign body, in the bladder, is exerted upon them.

That this view is correct is proved by some recent experiments of Henry Bence Jones,* made to ascertain, among other facts, the influence, upon the phosphates of the urine, exerted by the administration of some of the salts of lime and magnesia and of pure magnesia; all of which, he found, caused, in from $2\frac{1}{4}$ to 5 hours after their ingestion, a *marked increase in the proportion of earthy phosphates in the urine*, which continued, in some cases, for 27 hours. Proving that the administration of these substances must aid in the formation of Phosphatic urinary deposits and calculi.

Some interesting experiments by the indefatigable Boussingault,† "on the development of the mineral substance in the osseous system of the hog," are equally in point. In these experiments, some of these animals, of different ages,—after he had ascertained the weight of their osseous systems, by sacrificing similar ones of the same age,—were submitted, for a length of time to a specific diet, of articles in which the proportion of earthy salts was ascertained by analysis. The amount of these salts in their dejections, during the time of the experiment, was also ascertained.

* Phil. Trans. Roy. Soc., pt. 2, 1845.
† Comptes Rendus, &c., T. xxii, p. 356.

Finally, the increase of the mineral substance in their bones was estimated by weighing them, after killing the animals. The greatest increase in the osseous system was found to occur during the first eight months after birth.

In an ordinary mixed diet, he found, the food yielded as much of earthy salts as were discharged in the dejections, added to the actual increase of them in the osseous system; but when the animal was fed, for 3½ months, *exclusively on potatoes*,—a diet in which was found a deficiency of *lime* compared with the phosphoric acid,—he discovered that, during the time of the experiment, there had been deposited in the osseous system 52 grammes of lime more than the quantity contained in all the food consumed; besides a considerable amount which had been discharged in the dejections. In searching for the cause of this excess of lime he was led to analyze the water used by the animal, and found, in the quantity of that fluid which it had taken, rather more than enough lime to make up the deficiency. So that the lime contained in the water, had actually entered into the osseous system of the hog, and had served to supply the deficiency of that earth which existed in its exclusive diet.

Looking at the very small proportion of calculous patients in the poor population of Ireland, whose diet is mainly potatoes, with a very little solid animal food or thin milk, may not this marked fact give an index to one cause of their exemption?

In this connection it may be stated, as *a general fact*, that those countries which are noted for the purity of their waters, are also those which have the smallest proportion of calculous cases. For example:

*Ireland*, ~~is principally a~~ has a large central *coal district*, ~~as it regards its rock strata;~~ nearly surrounded ~~and~~ the inference is that its principal waters are not much impregnated with earthy carbonates.

The same is probably the case with *Bohemia*, which presents a

The counties of *Northumberland* and *Durham*, in England, in which calculous diseases are said to be very unfrequent, are ~~also~~ in the "coal region."

The county of Hereford, England, according to Mr. Smith,* is remarkably exempt from this disease. It has a population of

* Med. Chir. Trans. Vol XI.

mild temperature, containing coal &c and tertiary formations, surrounded by primitive ranges of mountains.

89,073, but during the 45 years from A. D. 1775 to 1820, no calculous case occurred in their hospital, although 16,248 patients were treated in it during that time. This county is ~~also in the coal and iron-ore~~ mainly in old red sandstone region. It is, moreover, more covered with "orchards" than any other part of England, and *cider* is very generally drunk by the inhabitants. It is remarked by agriculturists, that the *milk* of this county is more watery and makes less cheese than that of Cheshire and other richer counties.

*Bristol*, although surrounded by limestone, is seated on the *new red sandstone*, the waters in which are, however, somewhat impregnated with carbonate of lime. We are informed by Dr. Simonds,* that, while the water from the mountain limestone, becomes milky or boiling, by the deposition of carbonate of lime, that from the millstone grit, (also found near Bristol,) is extremely pure. These facts may account for the differences of opinion in relation to Bristol on the subject.

The inhabitants of the *granitic* county of *Cornwall*, and of the whole *Land's-end* region, in England, are, according to Dr. Forbes,† remarkably exempt from calculous disease; he also adds that the "water is remarkably free from saline and earthy matters."

Calculus is very rare in *Cheltenham*, England, according to Dr. Nash;‡ and "the water used is very pure and excellent." (p. 281.)

Dr Addison,§ in his Medical Topography of *Malvern*, states that although, in that locality, the springs and wells generally yield "hard waters, and the little streams have petrifying properties; St. Anne's and Holy-well, coming from the *primitive rocks* on the eastern slope, are remarkably free from earthy contaminations." He has seen the internal use of these waters decidedly beneficial in diseases and irritation of the bladder and disorders of the urinary organs, accompanied by the lithic acid deposits in the urine," and he attributes the benefit derived to the purity of the waters.

The Islands of *Malta*, *Goze and Cumino*, are of a soft limestone formation; but we are informed by Dr. Horner and others,‖ that the inhabitants are principally supplied with rain water. All

* Trans. Provincial Med. Assn., Vol. VII.
† Ibid, Vol. II.
‡ Ibid, Vol. V, p. 295.
§ Ibid, Vol. IV, p. 87.
‖ Med. and Topog. Obs. upon the Mediterranian, &c., and Encyclopedia Britan., article MALTA.

the "houses being built with flat roofs, plastered with puzzolano, with pipes conducting to cysterns, so that all the rain water is preserved." Moreover, we are told by Dr. Horner, that the inhabitants eat "little else than fruits and vegetables; seldom touching any sort of animal food," and that the appearance of the poorer classes indicates the greatest wretchedness.

On the other hand — in relation to *Copenhagen*, where calculus is so frequent, Dr. Otto informs us,* that the water used in that city "is *very impure*, containing, particularly, *carbonates of lime and muriates of potash and magnesia, and sulphates of lime, and silica*": and that, consequently, beer is the general beverage.

The city of *Norwich*, and the county of *Norfolk*, as well as the city of *London*, are seated on the tertiary formations of England, and doubtless underlaid by the chalk-rock, which must contaminate the water. We know that the water of London is very impure, as is also that of Paris, in both of which cities, calculus is quite frequent: but in relation to Norwich and Norfolk, we have less certain information. A rich marl, forms the subsoil

Calculous diseases is very frequent in Moscow, Russia. We are informed by Dr. Roos, of St. Petersburg,† that 1411 calculous patients were received into the Hospital St. Marie, at Moscow, during 28 years, (from 1808 to '36,) a great majority of whom were children. Dr. Roos attributes the cause of this great frequency of lithiasis among children in the government of Moscow, to the little care which the peasants take of their children; their stuffing them with *farinaceous* food, potatoes and cakes; and their dirty, small, smoky and stinking habitations. The *water*, he states, is also *impure* and bad, *containing earthy matters.*

The *Ionian islands*, are of a calcareous formation, and, doubtless, limestone also prevails in the Lombardo-Venitian dominions; which are both pointed out by Civiale as remarkable for the frequency of calculus, but with respect to the water or the diet used by the inhabitants, we have not sufficient data before us to speak. We are told, however, that the food of the inhabitants of Lombardy is principally maize, or Indian corn. ✗

It is demonstrated, by the facts already quoted, as well as by many others that might be given, did we not fear to extend this

* Trans. of Prov. Med. Assn., Vol VII.
† Gazette Med. de Paris, T. 6, (1838,) p. 810.

✗ The greater number of the Lexington cases originated in the limestone region, where the water is hard; - very few came from Sandstone district, which have pure soft water - (See ... [illegible]) paper to too great a size, that the nature of the *food* exerts an influence on the liability to calculous disease. This fact may be presented in the following relations, viz:

1. Uric acid and Urate of ammonia, which are the most frequent constituents of *nuclei*, contain a large proportion of nitrogen, and if a very rich diet be indulged in, of animal food, or the richer varieties of farinaceous food,—while a proportionate amount of exercise is not taken, to aid in the removal of the organic elements by the respiratory process, on the combined surfaces of the lungs and the skin,—the liability to calculus is increased, in consequence of the greater amount of nitrogenised solid matters which must be discharged by the kidnies.

2. On the other hand—if the diet is poor, being mainly composed of the watery vegetables, as the potatoe, turnip, carrot, beets, cabbage, pumpkin, &c., or of the succulent fruits.* the liability to calculous disease is much diminished; not only by the small relative amount of nitrogenous matters to be discharged, but also by the great increase they cause in the quantity of water in the urine, to dissolve and carry them off in solution.

As a general rule, the urine of carnivorous animals is acid, and very rich in Urea and Uric acid, and the earthy phosphates;† while that of herbivorous animals is pale, contains but little, if any, Urea and Uric acid, or phosphates; it is *alkaline* from the presence of the carbonate of potash derived from their food,‡ and turbid with the carbonates of lime and magnesia. Magendie found by experiment, that a dog, fed on non-nitrogenous food for 3 or 4 weeks, had no Uric acid in his urine; another dog, fed exclusively on sugar, died of inanition, and his urine contained neither Uric acid nor phosphates.§

3. Rich animal food, and dry farinaceous articles, contain a

---

* QUANTITY OF WATER IN 100 PARTS.

| | WATER. | AUTHORITY. |
|---|---|---|
| Cantelope melon, - - - | 98 | Payen. |
| Cucumber, - - - - | 97.15 | John. |
| Turnips, - - - - | 92.5 | Boussingault. |
| Cabbage, - - - - | 92.3 | " |
| Carrots, - - - - | 87.6 | " |
| Beets, - - - - - | 87.8 | " |
| Goosberries, - - - - | 86.5 | Berard. |
| Potatoes, - - - - | 75.9 | Boussingault. |

† Chevreul. Ann. de Chim. T. 67, p. 294.

‡ Boussingault, Comptes Rendus, &c., T. xxii, p. 4.

§ Magendie on Gravel, &c.

large proportion of *earthy phosphates;* and *this is more particularly the case with the Indian corn,* (maize,) which, with *bacon,* forms the principal and abundant food of the mass of the inhabitants of Kentucky; and doubtless, powerfully aids the limestone water in increasing their liability to calculous disease, by throwing a large proportion of earthy salts into the urine.

Our Indian corn is remarkably rich in *earthy phosphates,* and contains, especially when it has been kept for some time, but a small relative proportion of water.

During the present month, (September,) I took 100 grains of corn-meal, which had been made from last year's corn, and dried it at the temperature of about 300° Fah. It lost 12.7 grains of moisture. Another 100 grains was burnt in a red-hot platinum capsule; the combustion of the bulky charcoal being aided by the careful addition of nitrate of ammonia. The residue, which was still of a grey color from the presence of a little carbon, weighed 1.1 grain; and, upon examination with the proper reagents, was found to contain a large proportion of the phosphates of lime and magnesia. So that our *Indian corn contains rather more than one per cent. of earthy and other salts;* and if a person eats one pound a day, which is the allowance for a laboring man, he will take into his system, at the same time, nearly 80 grains of these inorganic materials, containing a large proportion of earthy phosphates, most of which must be thrown off by the kidneys.*

Indian corn was analyzed by Gorham, who found in it 7.2 grains of earthy phosphates to the ounce—1½ per cent. Dr. Rogers, on burning 100 grains of Brown corn, obtained one grain of ashes composed principally of phosphates of lime and magnesia, with a little silica and free phosphoric acid. He remarks: "Some interesting facts will be noticed in the variable proportions of phosphates in different varieties of the same species of grain, and the great preponderance of them in Indian corn, beyond what is contained in the smaller grains, like barley, oats and wheat—a fact that seems to explain their peculiar properties as food for animals; the more highly phosphatic grains

* All the earthy salts in the UNDIGESTED portion of food is, of course discharged in the fœces. Berzelius found 6 grains of earthy phosphates in 3 oz. of human fœces, and the average amount daily discharged has been estimated at 6 oz.; so that ordinarily only 12 grains of phosphates, per diem, pass off in that way. These proportions, however, vary according to circumstances.

being more likely to surcharge the system of adult animals with bony matter, producing concretions of phosphate of lime, like those resulting from gout."

"Perhaps the stiffness of the joints, and lameness of the feet, common in horses fed too freely with corn, may be accounted for by this preponderance of the phosphates. Young animals cannot fail to derive more osseous matter from corn than from any other food."*

Shepard obtained from 100 grains of corn, 0.95 grain of ashes, in which he found a large proportion of silex and phosphates, and a little carbonate and sulphate of lime and magnesia.

According to the analysis of Letellier,† the ashes of maize contain in the 100 parts, of

| | | | |
|---|---|---|---|
| Potash, } Soda, } | 30.8 | Magnesia, | 17.0 |
| | | Phosphoric acid, | 50.1 |
| Lime, | 1.3 | Silex, | 0.8 |
| | | | 100.0 |

Boussingault has also spoken, in his "Rural Economy," of a *deficiency of lime* in the composition of Indian corn; ~~but it is evident, from his statements, as well as from the analysis of Letellier, that~~ and although the maize of Europe, which will not compare, in size and luxuriance, with that of Kentucky, ~~contains also a much smaller~~ no marked difference in the proportion of phosphate of lime. ~~The corn grown in the limestone region of Kentucky contains a large proportion of that substance, as I have ascertained, in the *qualitative* analysis already mentioned.~~ has been made out by analysis ✗

That a comparison may be drawn of the relative amount of earthy phosphates in Indian corn, I will append a table from the works of Dr. Bird, Lehmann, &c., as follows:

| Articles of food. | Phosphates in 1 oz. | Authority. |
|---|---|---|
| Peas, | 9.26 grains, | Braconnot. |
| Maize, | 7.2 " | Gorham. |
| Wheat, | 4.7 " | Leibig. |
| Rice, | 1.92 " | Braconnot. |
| Potatoes, | 2.35 " | Liebig. |
| Beef, | 0.38 " | " |
| Dried Caseum, | 6 per cent. | Berzelius. |
| Black bread of Germany, | 0.31 " " | Lehmann. |
| Milk, | 0.2 " " | Schwartz. |

* Report of the Commissioner of Patents, 1845, p. 191.
† Journ. fiir prak. Chem. B xxxviii, S. 42.



✗ see my analyses of Corn in 4th Vol of Rept. of Geol. Surv. of Ky. &c &c

This table, it is to be recollected, represents the amount contained in the articles fully divested of water, which enters into some of them in so large proportion. With this correction in view the relative proportion of phosphates in corn, and the other grains, is seen to be very great; for while moisture exists in the grains in the proportion of only from 12 to 18 per cent., potatoes contain nearly 76 per cent., fresh beef about 74, and milk about 90 per cent. of water. In the dried meats, as bacon, which enters so largely into the food of the mass of the people in this region, as the amount of water is small, compared with that in fresh pork or beef, the quantity of earthy salts contained must be proportionately larger.

It appears, therefore, highly probable, that the use of the limestone water, and a corn and bacon diet, may be the principal cause of the great excess in the proportion of the earthy phosphates and oxalate of lime in the calculi of this region;—that the earthy carbonates in the water, by neutralizing, to some extent, the natural acidity of some of the animal fluids, may be the cause of the very small proportion of pure Uric acid, and the great proportion of Urate of ammonia, to be found in them:—and that both these causes acting together with, and superadded to, all the other circumstances predisposing to urinary deposits, to be found every where, occasion the great increase in the proportion of calculous disease which ~~is~~ was presented in this country. +

There are some remarkable circumstances to be noticed in this connection.

1. The proportion of calculous cases has greatly diminished in Lexington during the last fourteen years. Dr. Dudley recollects but two cases which originated in the city during that time; which, if his recollection is correct, as I have every reason to believe, gives, in an average population of 6,700, an annual proportion of only one in 47,000: a proportion rather smaller than that of Bristol and much less than that of London, Norwich and Copenhagen. To what this decrease is owing, cannot be easily ascertained. It is true that the use of cisterns for the preservation of the rain-water which falls on the roofs of the houses, has become quite common of late years in Lexington; and it is highly probable that a greater amount and variety of the watery vegetables, fruits and fresh meats, enters into the common diet, now, than

+ Calculus is much less frequent now than formerly, in this region; owing probably to the more general use of fresh vegetables and of rain-water collected in cisterns (1872) formerly; but neither of these changes appear sufficient in magnitude to account for the great amelioration.

2. A great number of the cases of Dr. Dudley have apparently originated before the patient was old enough to take solid food, or to drink much water: some having to all appearances, had gravel of *congenital* origin, and others having exhibited the symptoms of stone at a very early age. This anomaly is, however, more apparent than real: for if the fluids of the mother are chemically changed in composition, by the use of any peculiar drink or diet, the same change must of necessity be induced in the fluids of the child, in utero, or at the breast.

3. The negro population, who are amongst those most exposed to the causes specified, are the least subjected to calculous disease.

Their muscular exertion in the open air; the unusually free action of their skin; and hence their very perfect respiration, as well as their strong digestive powers, may be the causes of their immunity from this disease: as they also protect them from the gout, and the other diseases consequent on high living and little exertion.

It is well known that if respiration be imperfectly performed, or the action of the skin in any way checked, while the food taken contains a large amount of nitrogenous matters, the quantity of Uric acid and Urate of ammonia in the urine is very much increased. The great frequency of calculus in Norfolk, is mainly attributed, by Dr Yelloly, to its "*great bleakness of situation,*" as well as the large use of ill-fermented *farinaceous food.*

Drs. Prout and Bird have both remarked this relation between the skin and the kidnies. Dr. Prout says:* "The effects of cold and moisture are, however, more remarkably striking when they concur with the other exciting causes mentioned, viz: errors of diet, complete bodily inactivity, &c. In a warm and dry state of the atmosphere, when the cutaneous exhalation is active, such causes often scarcely affect the urine; but in cold and damp weather they are sure to be followed, even in the most healthy, by a *deposition of the alkaline lithates.*" That is to say of Urates of ammonia, soda, &c.

---

* On Stom. and Renal Dis. p. 174.

Dr. Golding Bird remarks,* "As a general rule, whenever the functions of the skin are impaired, where a due amount of secretion is not exhaled from the surface, an excess of nitrogen is retained in the blood, and ultimately separated by the kidney in the form of Urate of ammonia, or perhaps Urea. A person in apparently good health, experiences from exposure to a current of cold air a slight check to perspiration, and the next time he empties his bladder, he voids urine of a deeper color than is usual with him, and on cooling it becomes turbid from the precipitation of Urate of ammonia."

The same fact is observed in animals which feed on flesh, and whose respiration is imperfect; as in snakes and *diving* birds, whose solid urine is mainly composed of Urate of ammonia and other Urates. The presence of a large proportion of Urate of ammonia in Guano, the excrements of tropical sea-birds, has been the frequent subject of remark, as a fact opposed to the prevalent chemical theories of respiration and animal heat. But those birds are doubtless chiefly *divers*, and have their respiratory process much circumscribed by their frequent plunges beneath the water; consequently a large proportion of the nitrogen of their food is discharged in their solid urine in the form of Urates.

The climate of this middle region of the United States, is very liable to sudden vicissitudes. Situated at a distance from the ocean, or any great body of water; our relative temperature, in summer or winter, depends greatly on the direction of the winds: and frequently after a long season of warm weather, the consequence of a prevalence of the S. or S. W. wind, it suddenly changes to the N. W., N. E., or N.; bringing us the atmosphere of the polar regions, and often depressing the mercury as much as from 10 to 20° Fah. in the twenty-four hours.

Having perhaps already made this essay too long, I will conclude it by a summary of the means most likely to diminish the predisposition to calculous disease in this region, as follows:

1. The quantity of solid food, especially of a rich kind, should be proportioned to the amount of exercise used; and any diminution of the natural action of the skin, or of the respiratory pro-

---

*On Urinary Deposits, etc. p. 77.

cess, should be prevented by proper attention to clothing, ventilation, etc.

2. The use of too great an amount of dry articles of food, containing a large proportion of earthy salts,—such as bread ~~corn~~, dried meats, etc.—should be avoided; and their use should be tempered by that of a proper proportion of the watery vegetables and fruits; which, while they contain but a small relative proportion of these salts, yield a large quantity of water to dissolve them and carry them out of the system.

3. It would also be proper to use rain or cistern water, or hard water that has been *boiled;* instead of the common limestone water; whenever there is a tendency to phosphatic or oxalate of lime deposits.

---

## CALCULI FROM THE LOWER ANIMALS.

Among the specimens in our Museum, are two from the bladders of Hogs, and one from a Jackass.

The latter is from this vicinity, is of the size of a small hen's egg, and of a light brown color. It is mainly composed of carbonate of lime and carbonate of magnesia, with a small amount of oxalate of lime and animal matter.

One of the calculi from Hogs, came from the neighborhood of Pittsburgh, Pennsylvania, and has a central portion principally of phosphates, covered by a thin layer of oxalate of lime; while the exterior coat is carbonate of lime.

The other specimen, of the form and size of an elongated pullett's egg, is very remarkable in its properties.

Its specific gravity is low. Externally it appears porous, and of the texture of cork or rotten wood; of a light fawn color.

Under the saw it felt like cork, and the sawings were soft and light, easily reducible to powder in the mortar. The interior is also porous, of a *light cinnamon color*, or resembling that of the powdered Lapis Calaminaris of the shops. It presents a large oblong nucleus of the same appearance as the body, from which it is completely detached.

Heated in the platinum spoon, it melted into a black pasty mass, giving off a very fœtid odor of burnt animal matter, swelling and burning with a whitish flame, with a great deal of smoke, and leaving a bulky light charcoal; which, after complete incineration, left but a minute proportion of ashes.

Heated in a glass tube, it gave off moisture, melted into a dark frothy liquid, which when strongly heated yielded a very fœtid empyreumatic oil, of a dark color, and left a bulky charcoal lining the interior of the tube.

Water, alcohol, and ether, boiled with it, dissolved but a small amount: water the least and ether the most. Potash solution dissolved it into a dark brown solution, emitting a peculiar, disagreeable odor;—the solution was at first of greenish-brown color like that of bile.

Acetate of lead, boiled with the potash solution, was not blackened; so that it does not contain much sulphur.

Ammonia dissolved it, as did also a solution of carbonate of soda. It was precipitated from these solutions by the addition of an acid.

A stream of carbonic acid was transmitted through a potash solution of six grains of the calculus, for several hours, during two or three days; but only a portion of the substance was precipitated; which appeared of the color of the original concretion, and presented the same properties, except that its potash solution was of a light yellow color. Hydrochloric acid added to the remaining solution caused a copious precipitate, which after washing and drying, appeared of a dark brown color, in lumps, and did not materially differ in properties from the original substance. Being rather less fusible, and forming a darker solution with caustic potash.

In diluted nitric acid the powdered calculus dissolved easily on the application of heat, with a slight evolution of fumes: on evaporation to dryness it left a yellowish-brown incrustation, soluble in water, giving a slight precipitate with chloride of barium, and becoming reddish brown on the addition of solution of potash.

Concentrated sulphuric acid dissolved it, in the cold, into a reddish brown solution; from which water threw down a flocculent light colored precipitate. When this solution was made with heat it was of a clove-brown color, and water caused but a slight brown precipitate. Carbonate of ammonia caused no precipitate.

Oxalic acid solution dissolved it in small proportion.

This very singular substance, which appears to be a peculiar animal compound, containing a large porportion of carbon, presents many properties in common with that rare ingredient of urinary calculi, *Xanthine*, or *Xanthic oxide*. It differs from it, however, in some particulars. Whether it is, or not, a new animal substance, can only be ascertained by an organic analysis; which my present engagements prevent me from attempting at this time.

---

## ADVERTISEMENT.

In order to give additional interest to the collection of urinary calculi in the Anatomical and Pathological Museum at Lexington, those patients of Dr. Dudley who have taken with them the stones removed in his operations, are respectfully invited to send them to the undersigned for analyses and deposition in the Museum.

They can be sent by students coming to the Medical School, and if *particularly desired*, the one half of the calculus, showing its interior structure will be returned, with the history of its composition.

The name of the patient, date of the operation and residence at the time, should accompany the calculus.

ROBERT PETER.

---

### ERRATUM.

On page 13th, 12th line from bottom, instead of "uniform" read reniform.

(add to p. 28) In a letter to the author, from the late celebrated surgeon J. C. Warren of Boston Mass., dated May 21. 1850 he stated that "in the preceding 70 years not more than 60 cases of stone in the bladder had become subjects of surgical operations" — "more than half have taken their origin out of Boston and its vicinity. The whole State of Massachusetts is almost void of limestone. From the State of Maine I have removed, from a single town, Thomaston, four cases of Calculus. This town has abundance of calcareous rock."